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Merchant Guilds, Taxation and Social Capital*

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Abstract

We develop a theory of the emergence of merchant guilds as an efficient mechanism to foster cooperation between merchants and rulers, building on the complementarity between merchant guilds' ability to enforce monopoly over trade and their social capital. Unlike existing models, we focus on local merchant guilds, rather than alien guilds, accounting for the main observed features of their behavior, internal organization and relationship with rulers. Our model delivers novel predictions about the emergence, variation, functioning, and eventual decline of this highly successful historical form of network. Our theory reconciles previous explanations and the large body of historical evidence on medieval merchant guilds. In doing so, we also shed novel light on the role of the guilds' social capital, and its importance for taxation, welfare, and the development of towns and their government in medieval Europe.

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1 Introduction

Since the pioneering work by Greif *et al.* (1994), merchant guilds have attracted considerable attention by economists, and for good reason. This celebrated historical institution dominated trade for several centuries, and its development was inextricably linked with the growth of medieval towns and the rise of the merchant class. The merchant guild has also been viewed by many as a shining example of *social capital* — see, e.g., Putnam et al., (1993) — bringing major economic and social benefits, thereby suggesting a very valuable potential role for such social capital even in modern economies — see, e.g., Bardhan (1996), Dasgupta (2000), Raiser (2001) and Stiglitz (1999).

Is this positive view of merchant guilds justified? What role did the guilds' social capital play? What is the rationale for the way merchant guilds operated, and for their relationship with medieval rulers? We address these questions theoretically, and then confront our model's predictions with the available historical evidence. The objective is to shed new light on the reasons for the emergence, organization, functioning, and eventual decline of this highly successful historical form of network.

Our model presents a very different, although complementary, theory of the emergence and role of merchant guilds relative to the existing literature and in particular to Greif *et al.* (1994), who were the first to provide a formal model of merchant guilds. They developed a theory of *alien merchant guilds* — i.e., associations of alien merchants supported by the rulers of the polities in which they traded. Historically, though, most merchant guilds emerged as *local merchant guilds* — i.e., associations of local merchants that obtained recognition and privileges (including monopoly power over local trade) from their local rulers. Alien merchant guilds were typically formed by the members of local merchant guilds who were active in long-distance trade, and remained under the control and supervision of the guilds from the merchants' polities of origin. Moreover, only a subset of local merchant guilds went on to form such foreign 'branches', primarily in the main international trade centers. It is, therefore, of considerable interest to understand the economic rationale for the emergence of local merchant guilds, and the reasons why medieval rulers were willing to grant them recognition and privileges. This is all the more important as local merchants dominated medieval towns, many of which acquired considerable power and autonomy. Hence, studying the roots of merchants' organizations and their relationships with rulers is crucial in understanding the wider political economy forces that shaped the development of towns and states.

Medieval rulers did not possess a reliable civil service to collect taxes, and employed a variety of agents for this purpose. The taxation of trade was costly and inefficient, with many tolls levied in markets, as well as ports, river crossings, and other points of transit. We develop a repeated game between the ruler of a medieval polity and a large number of (local) merchants to show how merchant guilds emerged as a mechanism to foster cooperation between merchants and rulers, raising revenue for the latter more efficiently: merchant guilds were exempted from paying tolls,

and made direct transfers to rulers. This apparently straightforward alternative to reliance on tax collectors was far from simple to implement. In order to raise enough revenue for rulers, guild members had to secure collusive profits from trade. We study the conditions under which such collusion could be sustained, and its implications.

Effective collusion required that only guild members be authorized to trade, hence the granting of exclusive trading rights by rulers to merchant guilds. But, these exclusive rights had to be enforced, and used profitably. We identify two main channels through which guilds' social capital affected the sustainability of collusion. When applied to groups or networks, such as merchant guilds, the notion of social capital¹ typically refers to *cohesion* and *trust* among members, and to their resulting ability to enforce group norms and engage in effective collective action. In our model, social capital facilitates cooperation among guild members to achieve two important objectives: first, detecting and intervening to defeat attempts by non-members to undermine the guild's monopoly over trade; second, coordinating on profit-maximizing market strategies for the group, and appropriate punishments of any member who chooses to deviate. By reducing the cost of effective collusion, greater guild social capital tends to make granting recognition and privileges to guilds more attractive for the ruler. On the other hand, greater social capital within a guild also increases its bargaining power *vis-à-vis* the ruler (reflecting the greater degree of cohesion among guild members), allowing the guild to secure a part of the collusive profits it generates.

Our theory identifies a number of other important determinants, beyond the guild's social capital, of the ruler's choice between the merchant guild regime and the tax collector regime: these include the strength and uncertainty of consumer demand, the geographical and population characteristics of the polity, and the degree of patience of the merchants. The model therefore yields a rich set of empirical predictions: we confront these with the available historical evidence in Sections 4 and 5, where they help to shed light on the timing and variation of emergence of merchant guilds; on their organization, norms and behavior; on their relationship with rulers and their role in the development of medieval towns and their administration; and finally on their decline.

The welfare implications of merchant guilds are complex. Our model shows that only those with sufficient social capital would have been granted recognition and privileges by rulers, since they represented a less costly way of raising revenue than reliance on tax collectors. In this sense, merchant guilds represented an efficiency improvement relative to the taxation alternatives available at the time. From the perspective of consumers, we show that the merchant guild regime implied the same level of consumer prices as the tax collector regime, except when demand realizations were large enough to require guild members to coordinate on a price below the monopoly price: in this case, consumers were better off under the guild regime. These implications are favorable to merchant guilds. On the other hand, the guilds' social capital may

¹For definitions see, among others, Bourdieu (1986), Coleman (1990), Spagnolo (1999), Dasgupta and Stiglitz (2000), Glaeser, Laibson and Sacerdote (2002), Lin (2001), Putnam (2000), as well as Sobel (2002).

also have had less favorable welfare implications. Our model highlights one of these: effective collusion implied an upper bound on guild membership, which in some circumstances involved membership restrictions and exclusion. At the same time, the guilds' social capital, by increasing their bargaining power, enabled them to secure a share of collusive profits (net of transfers to the ruler). This generated inequality within the merchant class, with guilded merchants earning much more than other merchants who were excluded from trade.

The remainder of the paper is organized as follows. Section 2 presents a short introduction to merchant guilds and to the medieval taxation of trade, which motivates our model. Section 3 sets out the baseline model. Section 4 studies taxation and trade, and the conditions to sustain collusion. The choice between the tax-collector regime and the guild regime is first analyzed in section 5. This section also reviews the historical evidence on the model's predictions. We then extend the model in a variety of ways in section 6, and discuss the evidence on the resulting additional implications. The final section 7 compares our theory to alternative theories of the emergence of merchant guilds, and offers our concluding remarks. All proofs are in the Appendix.

2 Motivating evidence

This section briefly reviews the historical evidence on merchant guilds and on the taxation of trade in the Middle Ages, which motivates our model.

2.1 Medieval merchant guilds

Medieval merchant guilds were associations of merchants in a particular town or city. The merchants could be wholesale and retail sellers, and trade one or more types of good, including spices², wine, grain, timber, furs, herring, honey, textiles³, bullion, etc. Some merchant guilds, particularly in earlier periods, also extended membership to craftsmen, while separate craft guilds emerged increasingly as time went by, for a wide range of different craftsmen and artisans.⁴ The typical pattern in medieval towns was to have a single merchant guild, whose members were local merchants (*local* merchant guild), and as time went by a variety of craft guilds. The main exception was cities that were also important centres of international trade (such as Constantinople and Bruges), where guilds of merchants from different cities formed local branches or colonies (*alien* merchant guilds).

²According to Lopez and Raymond (2001), pp. 108-114, the term 'spices' came to include not only seasonings, perfumes, dyestuffs and medicinals, but also a much wider variety of goods. The list they present, from Pegolotti's manual of commercial practice dated between 1310 and 1340, includes obvious candidates such as anise, ginger, cinnamon, cloves, fennel, pepper and nutmeg, but also items as varied as asphalt, wax, glue, gum, indigo, ivory, lead, tin, rice, copper, coral, soap, sugar, sulphur, turpentine.

³Notably cotton, wool, and silk.

⁴For example, there were guilds of weavers, dyers, masons, painters, bakers, butchers, blacksmiths, soapmakers, etc.

2.1.1 Local merchant guilds

Our model focuses mainly on local merchant guilds. Historically, most merchant guilds emerged as associations of *local* merchants. These *local merchant guilds* were ubiquitous in medieval Europe (in England alone, for example, there were over one hundred towns with a local merchant guild).⁵ Local merchant guilds were supported by their local rulers, who granted them official recognition and a variety of important privileges, including *exclusive rights over local trade*.⁶

These privileges were sometimes granted as part of charters given to towns, which also gave the towns a degree of political, administrative and financial autonomy. This was the case in England, where many such town charters contained “a clause similar to the following: We grant a Gild Merchant with a hanse and other customs belonging to the Gild, so that [or ‘and that’] no one who is not of the Gild may merchandise in the said town, except with the consent of the burgesses...” (Gross, 1890, p. 8). Thus English local merchant guilds were granted the right to *exclude any non-member from trade*. In continental Europe, the granting of monopoly privileges to local merchant guilds was not always linked to the granting of greater political autonomy to towns. A good example is the guild of the *mercatores aque* (“water merchants”) in Paris: in 1170, the French king, Philip Augustus, “granted them a virtual monopoly of the Seine traffic between the bridges of Paris and Mantes...they increasingly assumed the responsibilities of municipal government under Philip’s grandson, Louis IX...The water merchants may be regarded as the embryo of the municipal government recognized later in the century.” (Baldwin, 1986, p. 348). Yet under Philip Augustus, “Unlike those of most towns in the royal domain, the bourgeois of Paris were permitted no semblance of autonomy” (Baldwin, 1986, p. 349 and Luchaire, 1902, p. 239).

The privileges granted to local merchant guilds in many medieval European cities meant that *alien* merchants could be either excluded from trade, or allowed to trade only subject to a number of restrictions clearly intended to favor local merchants.⁷ Among the most common of these restrictions were “staple” rights and brokerage rights. Local guilds’ “*rights of staple*” meant that alien merchants had to bring their merchandise to municipal warehouses where members of the local merchant guild could buy them at favorable prices.⁸ Local guilds’ *brokerage rights* meant that alien merchants could not trade directly with consumers or with other alien merchants: they had to use members of the local merchant guild as intermediaries (brokers).⁹

⁵See Gross (1890), pp. 9-16, for a list of all those for which there is explicit documentary evidence, many dating back at least to the eleventh and twelfth centuries. The actual number is likely to have been even greater, implying that by the thirteenth century, local merchant guilds were “one of the most prevalent and characteristic features of English municipalities.” (p. 22).

⁶See Bernard (1972), p. 304, Dilcher (1984), pp. 72-76, Ehbrecht (1985), pp. 430, 449, Fryde (1985), p. 220, Schütt (1980), p. 79.

⁷See Hibbert (1963), pp. 169-74, Irsigler (1985), p. 59, Leguay (2000), p. 121, Planitz (1940), p. 25, Postan (1973), pp. 189-91, Reyerson (2000), pp. 59-60, Schultze (1908), pp. 498-502, 506, 523, 526-7, Spufford (2000), p. 177.

⁸Bernard (1972), p. 302; Kuske (1939).

⁹Bernard (1972), p. 302, Choroskevich (1996), pp. 84-6, Hibbert (1963), p. 170, Schultze (1908), pp. 498-502, 506, 523, 526-7, Spufford (2000), p. 177.

Local merchant guilds often enjoyed several of these privileges: for example, the local merchant guilds in cities such as Bruges and Cologne enjoyed both staple rights and brokerage rights. Local merchant guilds also restricted access to towns: “Outsiders might enter and leave the town for purposes of wholesale trading only and for only a limited number of days, varying from place to place to between 14 and 40”.¹⁰ At the same time, local merchant guilds could exclude from trade *local* individuals who were not members of the guild.¹¹

2.1.2 Alien merchant guilds

Some local merchant guilds established foreign branches (“colonies” and “consulates”) in important trade centers, when a significant number of their members engaged in long-distance trade (many did not). These *alien merchant guilds* were closely linked to the local merchant guilds of their polities of origin: for example, merchants from a given town or city typically had to be members of the local merchant guild in their town or city in order to become members of any of its branches in other towns or cities, and being expelled from the local guild of their town or city of origin also entailed exclusion from all the alien merchant guilds linked to it.¹²

2.1.3 The development of craft guilds

Many merchant guilds included craftsmen as members early on. In England, for example, “The term merchant...was not in those days confined to large dealers, but embraced all who traded...Every master craftsman was regarded as a merchant, for he bought his raw materials, and sold the products of his handiwork in his shop or at his stall...The glover bought his skins; the baker his corn; the butcher sold hides as well as meat; the weaver, fuller and dyer bought wool and woad, and sold cloth” (Gross, 1890, p. 107). As time went by, trade, production and consumption grew, as did specialization, and craftsmen became increasingly organized in separate craft guilds. These were essentially occupational associations, grouping individuals specialized in a particular trade. As an illustration, consider the town of Shrewsbury, whose merchant guild already had 326 members by 1219.¹³ Craft guilds established subsequently included: the Barber–Chirurgeons (in 1304); the Shoemakers (1387); the Vintners (1412); the Fishmongers (1423); the Mercers and Goldsmiths (1425); the Weavers (1449); the Fletchers, Coopers and Bowyers (1449); the Carpenters and Tylers (1450); the Tailors and Skinners (1460); the Drapers (1462); the Tanners (1478); the Glovers (1478); the Saddlers and Painters (1478); and so on.

¹⁰Fryde (1985), p. 220.

¹¹Fryde (1985), p. 220, Planitz (1940), pp. 25–8, Postan (1973), pp. 189–91; Schütt (1980), p. 121, pp. 398–9, Schulze (1985), Woodward (2003), p. 3.

¹²Ogilvie (2011), pp. 108, 112.

¹³Fryde (1985), p. 220.

2.2 Medieval taxation of trade

The use of tolls or customs to tax trade in Europe can be traced back to the Roman imperial custom system.¹⁴ This included taxes on sales transactions and taxes on goods in transit. *Ad valorem* tax rates typically varied between 2% and 5%; there were also some fixed payments. Toll stations were situated at appropriate locations in the customs territories. Customs were collected thanks to close cooperation between civil administration and the army.

From at least the third century onwards, foreign merchants were subject to tight controls. In the Byzantine customs system, from the sixth century onwards, agents referred to as *comerciararii* were responsible for the *apotheke* ('customs houses' or 'commercial hostels'), where imported goods were bought and sold, and taxes collected. Official seals were attached to merchandise to prove that the appropriate tax had been paid. Under Charlemagne, trade was restricted to specific public markets, active at particular times and locations (*legitimus mercatus*): royal officials collected tolls from participating merchants.

In the post-Carolingian Middle Ages, when central authority was weakened and power dispersed, we nevertheless find many of the same basic features of trade taxation. Throughout medieval Europe, rulers tried to restrict trade to public markets, including a multitude of official fairs¹⁵, to ensure taxes could be collected.¹⁶ Tolls were collected at coastal ports as well as river and road toll stations, and mountain passes.

3 The baseline model

This section introduces our model. Consider a medieval polity with three types of risk-neutral players: a ruler, N identical merchants, and a tax-collector.¹⁷

The market. Merchants sell a homogeneous good and compete to attract a single representative consumer. In every trading period $\tau \in [1, \dots, +\infty)$ they quote prices. The consumer purchases one unit of the product. His utility from consumption is

$$u(v^\tau, p^\tau) = v^\tau - p^\tau,$$

when (in period τ) he buys at price p^τ , and zero otherwise. The willingness to pay for the product v^τ is a random variable identically and independently distributed over time: for simplicity, it is equal to $\Delta > 0$ with probability α and to 0 otherwise.

¹⁴Our brief review of the early medieval taxation of trade, including its Roman background, draws substantially on Middleton (2005).

¹⁵Probably the most famous example of medieval fairs is that of the Champagne fairs, but of course there were very many other fairs and markets, including numerous local ones accommodating primarily local trade.

¹⁶See, for example, Dijkman (1960), pp. 34-37, and Middleton (2005), p. 320.

¹⁷We explicitly focus on risk-neutral parties in order not to rely on risk-sharing mechanisms that have been already analyzed in the network literature applied to economic history — see, e.g., Abramitzky (2008). We discuss the relationship between our model and this literature in section 6.

The ruler. The ruler governs the polity: he provides certain public goods, such as law enforcement and defence, and finances these with various sources of revenue, including the taxation of trade. He also spends on activities that provide him with private benefits, such as military campaigns and court display.¹⁸ For our purposes it is sufficient to treat his expenditures and his other sources of revenue as given exogenously, and to focus on the revenue he can raise from the taxation of trade. The ruler is assumed to maximize this revenue. This is a reasonable assumption for the historical period under consideration, when rulers typically attached a low weight to the well-being of ordinary consumers.¹⁹

To maximize his revenue from local trade, the ruler has two options. First, he can employ a tax collector (see the discussion of tolls in Section 2). Second, he can grant recognition and exclusive rights over trade to a merchant guild, in return for an appropriate transfer. These are essentially, from a fiscal perspective, two alternative taxation regimes. Let us consider each regime in turn, starting with the second option.

The guild. If the ruler chooses to grant recognition to a merchant guild, he endows it with privileges, notably the power to exclude individual merchants from trade (see the discussion of merchant guilds' exclusive rights in Section 2). However, the exercise of this power is not costless. Specifically, there are two kinds of duty that guild members must perform in order to enforce the guild's monopoly over trade and earn monopoly profits. First, when the guild has size $n < N$, insiders need to exclude from trade outsiders. We assume that this exclusion effort requires a total per-period investment equal to $x(N - n)$, which is shared equally among guild members. This cost obviously increases with the number of outsiders to be excluded. It represents the cost of monitoring to detect any attempts by non-members to undermine the guild's monopoly, and intervening to ensure the attempts are not successful. Greater cohesion and trust among guild members (i.e. greater social capital) will reduce this cost, making it easier to cooperate, communicate and avoid free-riding problems. In the baseline model we assume that effective exclusion is only possible if every member contributes — i.e., pays the individual cost $x(N - n)/n$: then outsiders are unable to trade. Otherwise, outsiders can successfully undercut the price that the guild members have agreed to charge. In the extensions to the baseline model we show that our results continue to hold when we assume a different monitoring technology, in which limited free-riding is less harmful.

The second type of duty required for the guild to operate successfully is an internal organization and coordination effort. This entails a total per-period cost $(n - 1)f$, which captures the investment guild members must collectively sustain to coordinate successfully their actions — i.e., the cost of defining and agreeing on their common market (pricing) strategy, of designing guild rules including a punishment code, of exchanging information, etc. We can think of this to some extent as a time cost: guild members had to participate in collective activities, such as

¹⁸For historical evidence on the importance of these see, e.g., Brewer (1989).

¹⁹See, e.g., Bisson (2009), pp. 352-355.

meetings, social and religious gatherings, elections of guild officers, admission of new members, and so on. Importantly, the disutility of spending time on these collective activities will be lower in groups that have greater social capital, interpreted here as greater cohesion, closer ties, and more congruent preferences. Moreover, more social capital within a guild will also make coordination easier through greater trust and easier reliance on shared information. We will return to this interpretation of f as reflecting social capital below.

When the ruler grants recognition and privileges to a merchant guild, he requires an ex ante fee R^G , which is shared equally among the guild's members.²⁰ This fee is set at the level which solves a standard Nash-bargaining problem between the ruler and the guild with weights β and $1 - \beta$, respectively.²¹

The tax-collector. In the absence of merchant organizations, the ruler delegates trade taxation to an agent: the tax-collector. Specifically, he endows the agent with the right to collect taxes on trade in the polity, in return for an ex ante royalty fee R^T . This is essentially 'tax farming', a very widespread practice in medieval Europe — see, e.g., Lyon and Verhulst (1967) and Webber and Wildavsky (1986). In every period, the tax-collector chooses a tax t^τ that merchants have to pay on each unit of product they sell. The tax revenue that he can levy is t^τ as long as trade occurs. Collecting taxes is costly, and the cost increases with the revenue to be raised: for example, more time needs to be spent at public markets and toll stations (see the discussion of medieval trade taxation in Section 2). We model this by assuming that in every trading period τ the tax collector pays a cost $c(t^\tau) = \psi t^\tau$, with $\psi \in [0, 1]$, which is increasing in the revenue t^τ that can be extracted from the merchants.

Payments to rulers and commitment. We assume that the ruler can commit to the chosen taxation regime at $\tau = 0$, so that in both regimes payments to rulers take the simple form of a single ex-ante fee. This makes it possible to identify clearly some of the key trade-offs between recognizing a guild and relying on a tax collector, abstracting from commitment problems. We discuss the implications of imperfect commitment in the section on extensions to the baseline model.

Timing and strategies. At time $\tau = 0$ the ruler decides whether to grant recognition to a merchant guild or hire an agent as tax-collector. In every trading period $\tau \geq 1$ the game proceeds as follows:

- Demand realizes;
- Merchants quote prices;

²⁰ As will be discussed in the next section, guild members typically paid some entry fees, as well as a variety of other dues. The guild then made transfers to the ruler.

²¹ Greater cohesion among guild members (more social capital) will increase their ability to bargain successfully with the ruler, increasing their share of collusive profits.

- Trade takes place.

There is perfect monitoring: if a guild member deviates by undercutting in any period, the other members observe the identity of the deviating “brother“ by the end of that period. This assumption seems reasonable in the case of medieval polities. Indeed, as discussed in Section 3, most of the trading activities at that time were taking place in public markets where merchants could easily monitor each other’s pricing strategy.

All agents have a common discount factor $\delta \in [0, 1)$. The equilibrium concept is *subgame perfect Nash equilibria* (SPNE). Finally, in the baseline model we assume that

$$\Delta \geq (N - 1) \max \left\{ x, \frac{f}{\alpha} \right\}. \quad (\mathbf{A1})$$

This assumption simply allows for the possibility of a single-member guild — i.e., the revenue that can be obtained from trade is greater than the cost of excluding all but one merchant — and a guild that includes every merchant in the polity — the (expected) revenue is greater than the operating costs when all merchants are admitted to membership of the guild. In the extensions to the baseline model we will relax this hypothesis.

4 The basic trade-off facing revenue-maximizing rulers

We begin by characterizing the profit that the ruler can achieve when merchants are not organized in a guild, and then proceed to examine the role of guilds.

4.1 Trade and taxation in the absence of merchant guilds

Suppose that the ruler hires an agent entitled to impose taxation and collect the corresponding revenue. The tax rate is chosen to maximize the revenue from taxation. We will solve the game using a backward-induction logic. Assume that $t^\tau \geq 0$ is the per-unit tax that merchants have to pay in period τ . In that period merchant i earns a profit equal to

$$\pi_i^\tau(\mathbf{p}^\tau) = D_i^\tau(\mathbf{p}^\tau)(p_i^\tau - t^\tau),$$

where $\mathbf{p}^\tau \equiv (p_1^\tau, \dots, p_N^\tau) \in \mathbb{R}_+^N$ is the vector of prices quoted by the N competing merchants in period τ . Merchant- i ’s individual demand is

$$D_i^\tau(\mathbf{p}^\tau) \equiv \begin{cases} 0 & \Leftrightarrow p_i^\tau > \min \{\mathbf{p}^\tau\} \\ \frac{1}{\#\{j: p_j = \min \{\mathbf{p}\}\}} & \Leftrightarrow p_i^\tau = \min \{\mathbf{p}^\tau\} \end{cases},$$

which is equal to $\frac{1}{M}$ if $M \leq N$ merchants (including i) quote the lowest market price and thus share the consumer's demand uniformly, and is equal to zero otherwise.²²

Hence, the tax collector will optimally set $t^\tau = \Delta$ in every trading period in which $v^\tau = \Delta$ and $t^\tau = 0$ otherwise, so as to implement the monopoly outcome. The tax collector's (expected) intertemporal profit is

$$V^T = \frac{\alpha\Delta(1-\psi)}{1-\delta} \geq 0,$$

which is increasing in the consumer's expected willingness to pay $\alpha\Delta$, and decreasing in the cost of collecting taxes ψ . The ruler fully extracts this surplus by setting $R^T = V^T$.

4.2 Merchant guilds: trade, taxation and privileges

Suppose now that $n \leq N$ merchants organize themselves as a group able to act in their collective interest: the guild. The ruler grants privileges to them and, in particular, monopoly power over trade — i.e., only members of the guild are officially authorized to trade. Under what conditions can the guild implement a better outcome than the tax collector, from the ruler's point of view?

To answer this question we must first examine how the viability of effective collusion among guild members, yielding monopoly profits for the guild, depends on the parameters of the model, and the implications this has for the guild's optimal size, as well as its performance relative to the tax collector. Before providing the equilibrium analysis it is useful to frame the timing of the game within each stage. The sequence of moves within every trading period τ is as follows:

- Merchants decide whether to pay the operating cost or not.
- Demand realizes.
- Merchants simultaneously and independently quote prices and decide whether to pay the exclusion cost.
- Profits realize.

We will look for a SPNE of the game in which in every trading period guild members pay the operating cost, while they exclude outsiders and charge the monopoly price $p^M = \Delta$ if and only if $v^\tau = \Delta$. Such an outcome can enforce the monopoly outcome as long as: (i) each merchant does not profit from undercutting the monopoly price; (ii) it is in each merchant's best interest to pay both the operating and the exclusion costs. The punishment code is the simplest one could imagine: following any deviation (be it a price deviation or simply free-riding on exclusion and operating costs) the guild is dissolved and merchants price competitively — i.e., $p = 0$ — so that each obtains a profit equal to zero, which is the lowest payoff they can obtain. In this sense the punishment is optimal. Alternatively, one could assume that if a member deviates, the

²²The implicit assumption here is a uniform tie-breaking condition, which is standard in market games with homogenous sellers.

other guild members exclude the deviating member at the cost of x , and continue to operate the guild, colluding to set the monopoly price without him. This punishment code will be preferred if it is more profitable for the guild members that do not deviate. In both cases the deviating member is punished with a zero payoff. Thus, our equilibrium analysis does not hinge on the specific way the zero-profit punishment is enforced after deviation.

The equilibrium described above must be immune to three types of deviations. First, every guild member should be willing to pay his share of the guild's operating (organization and coordination) costs. This will be the case as long as the continuation value of doing so is positive — i.e., each member's expected profit is non-negative on equilibrium path

$$\frac{\alpha(\Delta - x(N - n)) - (n - 1)f}{n} \geq 0 \quad \Leftrightarrow \quad \Delta \geq x(N - n) + \frac{(n - 1)}{\alpha}f. \quad (1)$$

Second, every guild member should be willing to contribute to the exclusion effort. Given that the guild cannot make profits if the exclusion cost is not entirely paid, it is easy to show that each merchant will contribute as long as

$$\Delta \geq x(N - n),$$

which is obviously implied by (1).

Third, no guild member should be tempted to undercut the others. Formally, undercutting the monopoly price is not profitable as long as the following self-enforceability constraint holds

$$\frac{\Delta - x(N - n)}{n} + \frac{\delta}{1 - \delta} \left[\frac{\alpha(\Delta - x(N - n)) - (n - 1)f}{n} \right] \geq \Delta - \frac{x(N - n)}{n}. \quad (2)$$

The left-hand side captures the (discounted) expected gain from cooperation, while the right-hand side is the spot gain from deviation. The continuation payoff after deviation is zero given the guild's punishment code. Note that (2) implies (1). Hence, undercutting in the positive demand state is the only deviation that must be taken into account. Of course, deviations are not feasible when the demand state is low — see Section 6 for an extension of the model to a continuous demand state.

Rearranging condition (2), it follows that collusion is sustainable as long as

$$\Phi(n) \equiv \underbrace{\frac{\delta\alpha}{1 - \delta} [\Delta - x(N - 1)]}_{\geq 0 \text{ by A1}} - (n - 1) \left[\Delta + \frac{\delta}{1 - \delta} (f - \alpha x) \right] \geq 0.$$

Notice that the impact of the guild density n on the self-enforceability constraint is ambiguous. In fact, differentiating with respect to n we have

$$\frac{\partial \Phi(n)}{\partial n} = - \left[\Delta + \frac{\delta}{1 - \delta} (f - \alpha x) \right] \geq 0 \quad \Leftrightarrow \quad x \geq \bar{x} \equiv \frac{f}{\alpha} + \frac{(1 - \delta)\Delta}{\alpha\delta}.$$

This expression suggests that there are three effects shaping the way a higher density n impacts the incentive to undercut the monopoly price. First, other things being equal, as n grows larger each guild member is more tempted to undercut p^M because the monopoly profit must be shared among more people — i.e., the individual revenue from collusion Δ/n becomes smaller as n increases. Second, operating costs are increasing in guild size, thus a higher n , by increasing coordination costs, tends to make collusion less appealing because the continuation value of cooperation shrinks. Third, a higher density reduces the cost of excluding outsiders, which (other things being equal) tends to make collusion easier to sustain since it increases the continuation value of cooperation. This effect becomes stronger when the cost of excluding each outsider x grows larger. It should be noted that α and Δ have a quite different impact on \bar{x} : a higher α tends to reduce it, while a higher Δ increases it. Thus Δ and α play a different role in the analysis.

Summing up, while the first and second effects point in the direction of making collusion harder to sustain when n increases, the third effect goes in the opposite direction. We can therefore establish the following result.

Lemma 1 *If $x \geq \bar{x}$ collusion is always viable in the guild regime regardless of n . Otherwise, collusion can be sustained if and only if*

$$n \leq \bar{n} \equiv 1 + \frac{\Delta - x(N - 1)}{\bar{x} - x},$$

where \bar{n} decreases with f , and increases with α , δ , x and Δ .

This result shows that if the exclusion cost x is sufficiently large, the third effect described above dominates — i.e., when $x \geq \bar{x}$ larger guilds are more profitable because they are able to better minimize total exclusion costs. Hence, as the number of insiders grows larger it is easier to sustain the monopoly outcome, meaning that as long as a single-member guild is viable (as stated in assumption **A1**)²³ the monopoly outcome is sustainable regardless of guild size. When instead exclusion costs are not so important and the other two effects dominate, there is an endogenous upper-bound on guild size — i.e., $n \leq \bar{n}$. Essentially, guilds that are excessively dense bear high coordination costs and are less able to deter price deviations. Hence, collusion is viable only if the guild density is not too large. This constraint becomes tighter when coordination costs are higher, as reflected by a larger f ; it softens instead when the probability of being in a positive demand state increases, as reflected by a higher α ; when the market becomes more valuable, as reflected by a higher Δ ; when merchants become more patient, which is captured by a higher discount factor δ ; or when exclusion is more costly, as reflected by a higher x .

²³We consider the case in which this assumption is violated in the section that examines extensions to the baseline model.

The guild density is chosen so as to solve the following maximization problem

$$\max_{1 \leq n \leq N} \frac{\alpha (\Delta - x (N - n)) - (n - 1) f}{1 - \delta},$$

subject to $\Phi(n) \geq 0$.

Note that the impact of the density on the guild's objective function is ambiguous. When n increases the cost of excluding outsiders shrinks: insiders need to exclude fewer outsiders. However, as the number of insiders grows larger the guild's operating cost also increases since coordination becomes more expensive. Hence, the guild's objective function is increasing in n if and only if

$$x \geq \underline{x} \equiv \frac{f}{\alpha}.$$

As we have already shown above, the impact of the density on the self-enforceability constraint is ambiguous too. This makes the choice of the guild's size a non-obvious problem. The key insight is that while the objective function is increasing in n as long as $x \geq \underline{x}$, the self-enforceability constraint (2) softens as a response to a higher n if $x \geq \bar{x} > \underline{x}$, meaning that even if exclusion costs are large enough to induce a positive relationship between the guild's expected profit and its density, it may well be the case that a larger density amplifies each member's incentive to undercut the monopoly price — i.e., $x \leq \bar{x}$.

Let n^* be the optimal density and denote by $W(n^*)$ the value function associated with the guild's maximization problem. In the next proposition we examine how the tension between the two effects just described shapes the optimal guild size.

Proposition 2 *The solution of the guild's maximization problem has the following features:*

- If $x \leq \underline{x}$, then $n^* = 1$. The guild's intertemporal profit is

$$W(n^* = 1) \equiv \frac{\alpha (\Delta - x (N - 1))}{1 - \delta}.$$

- If $x \in [\underline{x}, \bar{x})$, then $n^* = \min \{N, \bar{n}\}$. The guild's intertemporal profit is

$$W(n^* = \min \{N, \bar{n}\}) \equiv W(1) + \frac{(\min \{N, \bar{n}\} - 1) (\alpha x - f)}{1 - \delta}.$$

- If $x \geq \bar{x}$, then $n^* = N$. The guild's intertemporal profit is

$$W(n^* = N) \equiv \frac{\alpha \Delta - f (N - 1)}{1 - \delta}.$$

Hence, the guild's ability to exclude outsiders plays a crucial role in the trade-off discussed above. This ability will depend on several factors, including the geographical and population characteristics of the polity, which may make it easier or harder to detect alien or excluded local

merchants who engage in unauthorized trade, as well as the polity's openness to foreigners, and its attractiveness to alien merchants. The ability to exclude non-members from trade will also depend, on the other hand, on the degree of trust among guild members, and the extent to which they are able to overcome free-riding incentives and cooperate to monitor and intervene effectively: in other words, on their *social capital*. Thus social capital affects several parameters in our model: greater social capital tends to reduce exclusion costs, parameterized by x , and also coordination costs, parameterized by f , as discussed earlier. Moreover, it will tend to increase the guild's bargaining power relative to the ruler, captured by β . However, as we shall see, it is the effect on x and f that is important for the choice between the guild regime and the tax collector regime.

Solving the model backward, the Nash bargaining problem between the guild and the ruler is:

$$\mathcal{P} : \max_{R^G \in \mathbb{R}_+} (R^G - V^T)^\beta (W(n^*) - R^G)^{1-\beta}.$$

where V^T is the ruler's outside option, which is the expected payoff he would obtain by hiring a tax-collector. The outside option of the guild is zero since merchants would make no profits if a tax-collector were hired. It is then immediate to verify that the solution of \mathcal{P} entails:

$$R^G = V^T + \beta [W(n^*) - V^T],$$

which also defines the ruler's profit from granting recognition and privileges to a guild.

5 Merchant guild versus tax-collector

Building on the previous results, we can now examine under which conditions the ruler prefers to recognize a merchant guild rather than hiring a tax collector. Comparing R^G and V^T we find that

Proposition 3 *The ruler's profit maximizing strategy is as follows:*

- When $n^* = 1$, the ruler prefers to grant recognition to the guild if and only if

$$\psi \geq \psi_0 \equiv \frac{x(N-1)}{\Delta} \in (0, 1),$$

otherwise he prefers to hire the tax collector. The threshold ψ_0 is clearly increasing in x and N , and decreasing in Δ .

- When $n^* = \bar{n}$, the ruler prefers to grant recognition to the guild if and only if

$$\psi \geq \psi_1 \equiv \psi_0 - \frac{(\Delta - x(N-1))(\alpha x - f)}{\Delta \alpha (\bar{x} - x)} \in (0, 1),$$

otherwise he prefers to hire the tax collector. The threshold ψ_1 is increasing in x , f and N , and decreasing in Δ , δ and α .

- When $n^* = N$, the ruler prefers to grant recognition to the guild if and only if

$$\psi \geq \psi_2 \equiv \frac{f(N-1)}{\Delta\alpha} \in (0, 1),$$

otherwise he prefers to hire the tax collector. The threshold ψ_2 is increasing in f and N , and decreasing in α and Δ .

Intuitively, the ruler's choice between the guild regime and the tax collector regime depends on the costs associated with each. The guild regime can entail two types of cost, coordination costs and exclusion costs, whose relative importance varies with guild size. These costs need to be weighed against the cost of relying on an agent to collect taxes. Proposition 3 clarifies this trade-off. It shows how the relative attractiveness of guilds depends both on their internal characteristics - their social capital, which affects f and x - and on characteristics of the polity, which influence current and expected future demand, as well as the number of potentially active merchants, and the cost of excluding non-members from trade.

Proposition 3 has clear-cut comparative statics predictions: merchant guilds are more likely to emerge, other things being equal, when Δ , α , δ and ψ are higher, and f , x and N lower. Paucity of data for the historical period under consideration makes it very difficult to verify these empirically; nevertheless, it is possible to obtain some information from historical sources such as charters granted by rulers, municipal records, court records, and guild statutes. We consider evidence from such sources below, while emphasizing the important caveat that many records and documents from the eleventh, twelfth and thirteenth centuries (and of course earlier) have been lost. Indeed, some of the important work carried out by medieval historians entailed trying to infer information about lost documents from occasional references to such documents in subsequent, surviving ones.

5.1 Empirical validation

Our model yields a number of implications for the emergence, operation and decline of merchant guilds. We now review the historical evidence on these predictions.

Other things being equal,

- 1 Guild emergence:** *Guilds are more likely to emerge when the expected profitability of trade, represented by Δ and α , is higher.*

Historically, the European economy started to grow substantially in the eleventh century: the period until the fourteenth century witnessed a dramatic increase in production, trade,

and consumer demand.²⁴ This is the period when local merchant guilds emerged and became widespread.²⁵ Moreover, as the model would predict, merchant guilds were typically established in towns, and not in smaller market centres, where trade yielded revenue for rulers through tolls collected by officials.²⁶ For example, merchant guilds were established early on in most of the largest²⁷ eleventh century towns in England, as estimated on the basis of data from the Domesday Book (1086), such as Winchester, York, Lincoln, Oxford, Ipswich, Canterbury, Gloucester, Nottingham, Leicester, Bury St. Edmund's, Dunwich, and Wallingford.²⁸ Towns such as Ludlow, Poole, and Weymouth, that began to develop during the twelfth century, appear to have been granted merchant guilds later on.²⁹

Larger towns could be expected to have both higher Δ (larger market size), and higher α (since greater economic diversification would tend to reduce the risk of very unfavorable demand states). For example, in his detailed study of the West Midlands of England, Dyer (1992, p.145) notes how "all of the towns had much in common, notably in their varied occupations - 15 or 20 are recorded for some of the lesser towns, rising to 50 in the case of Worcester³⁰... The bigger towns gave opportunities for a wider range of specialists, as well as for traders on a large scale". Note however that larger towns are also likely to have had a larger population of potentially active merchants, N . Thus we would expect guilds in these towns to have had plenty of social capital, enabling them to be either large and inclusive, yet able to coordinate easily and successfully (i.e., low f), or more exclusive, with fewer, well-organized members able to cooperate successfully and deter any attempts by non-members to undermine their monopoly over trade (i.e., low x). We therefore turn to the evidence on social capital.

2 Social capital: *Guilds are more likely to be granted recognition if they possess more social capital, represented by lower x and f , enabling them to coordinate efficiently their strategies and sustain their monopoly profits.*

Merchant guilds were social networks whose members participated in a variety of social and religious activities together; they held regular assemblies and feasts; when abroad, they lived in their own quarters of foreign cities and interacted closely. At home as well as abroad, they provided mutual assistance when in difficulty.³¹ Close and repeated interaction facilitated monitoring and the exchange of information, helping to build and sustain trust and cohesion.

²⁴ Spruyt (1994), pp. 61-63.

²⁵ Dilcher (1984), pp. 72-76; Hickson and Thompson (1991), pp. 137-8; Woodward (2005), pp. 631-3.

²⁶ For many examples of such smaller market centres, and their tolls, see Britnell (2000).

²⁷ A town with at least 2000 inhabitants was 'large' at the time.

²⁸ Gross, 1890, pp. 9-16, gives the following dates for the earliest reference to these towns' merchant guilds: Winchester (Henry II), York (1130-1), Lincoln (Henry II), Oxford (Henry II), Ipswich (1200), Canterbury (1093-1109), Gloucester (1200), Nottingham (c.1189), Leicester (1107-1118), Bury St. Edmund's (1198), Dunwich (1200), Wallingford (Henry II). The mention Henry II refers to charters given by Henry II, King of England in 1154-89.

²⁹ Gross, 1890, pp. 9-16, gives the following dates for the earliest reference to these towns' merchant guilds: Weymouth (1442), Ludlow (1461), Poole (1568).

³⁰ Our note: Worcester indeed had a merchant guild.

³¹ Coornaert (1948), p.218; Gross (1890), pp.34-5.

The historical evidence from surviving records shows that merchant guild members *cooperated to enforce and protect their exclusive rights*. They did this in a variety of ways. Their exclusive rights, granted at earlier dates, were sometimes challenged in subsequent periods, and merchant guild members cooperated to defend them in court. For example, “In 1330 the major and community of the town of Bedford were summoned to answer to the king by what warrant they claim to have a Gild Merchant... so that anyone who is not of that Gild may not merchandise...”. In reply to the summons, “the burgesses show a charter of Richard I, granting a Gild Merchant...” and argue their case.³² Similar examples are available for other merchant guilds.³³ There are also records of merchant guild members intervening directly to enforce their exclusive rights, and then defending their intervention in court when challenged.³⁴ For example, “In 1280 several burgesses of Newcastle-under-Lyme were summoned by the king for seizing ten fleeces of wool belonging to Richard the Baker of Stafford... They say that they seized Richard’s wool because he bought it contrary to the liberty of the Gild; and they show a charter of Henry III...”.³⁵

Merchant guilds often opposed powerful lords: for example, “Alan Basset lord of Wycombe... attempted to get rid of the gild merchant and allow free trade in hides and wool in the town. The burgesses, in this case synonymous with the gild, brought an action against him in the King’s Court (Curia Regis) claiming that they had their gild merchant by charter from King John”.³⁶

Merchant guild members successfully *coordinated on profit-maximizing strategies vis-à-vis alien merchants*. This did not always entail complete exclusion - in particular, restrictions were often relaxed on particular days, “no one, except a gildsman, shall buy honey, suet, salt herring, nor any kind of oil, nor mill-stones, nor fresh leather, nor any kind of fresh skins; nor keep a wine-tavern, nor sell cloth by retail, except on market and fair day”.³⁷ As Gross points out, “gildsmen were enlightened enough to perceive that more complete freedom of trade on those days attracted a greater multitude of people... and thus conduced to their commercial prosperity”.³⁸ Yet guild members often enjoyed pre-emption rights: for example, the Southampton ordinances dictated that “no simple inhabitant nor stranger shall bargain for nor buy any kind of merchandise coming to the town before burgesses of the Gild Merchant”.³⁹

Thus successful coordination and cooperation by guild members required elaboration and implementation of more complex strategies when dealing with alien merchants than simply

³²Gross, 1890I, p. 37. Note that Richard I was King of England in 1189-1199.

³³For example, Chester, Beaumaris, Conway, Bala, Newborough, Carnarvon, Harlech, Criccieth, Macclesfield (Gross, 1890, pp. 38-39, 42).

³⁴It is precisely thanks to surviving court records that we have this kind of evidence. It seems likely that many such cases were unchallenged and hence unrecorded.

³⁵Gross, 1890, p.39. Note that Henry III was king of England in 1216-1272. Gross (p. 14) gives 1235 as the earliest reference to the merchant guild of Newcastle-under-Lyme.

³⁶The quotation is from Fryde (1985), p. 222, citing as source: Curia Regis Rolls of the Reign of Henry III, vol. XI, 7-9 Henry III (London 1955), p. 415, no. 2055.

³⁷Extract from the ordinances of Southampton, cited by Gross (1890, p. 47).

³⁸Gross (1890), p. 47.

³⁹Gross (1890), p. 48.

fixing prices by guild members and excluding everyone else. These also included requirements for alien merchants to “bring their wares to ‘the Common Hall’ or other specified public place, and there expose them for sale, in order that their goods could be more easily examined, and their mercantile transactions more readily supervised”.⁴⁰ Moreover, alien merchants were often restricted to a maximum number of days they could remain in the town, and “during this time they were carefully watched, lest they should sell or buy under... cover of a faithless gild-brother’s freedom, the latter being expelled from the fraternity or otherwise severely punished, if found guilty of this offence”.⁴¹

Coordination and cooperation among guild members was further enhanced by a variety of *guild norms*; for example, “the gildsman was generally under obligation to share all purchases with his brethren, that is to say, if he bought a quantity of a given commodity, any other gildsmen could claim a portion of it at the same price at which he purchased it”.⁴²

3 Guild decline: *Guilds are more likely to decline when the cost of relying on agents to collect taxes (ψ) decreases, and when characteristics of the polity make it harder for guilds to enforce their monopolies over trade (increasing x and/or f).*

The timing of merchant guilds’ decline is debated by historians. One reason for this is that some historians focus on the elimination of guild entry restrictions, while others focus on the loss of power of guilds, and their changing role. For example, Hickson and Thompson (1991, pp. 154), based on the first criterion, view the demise of guilds as starting in the 17th century (Holland and Zeeland), and gathering pace in the 18th (first in England, followed by France, Flanders, Italy, Spain, Germany); while Ogilvie (2011, pp. 31), based on the second criterion, sees it as starting already “after about 1500, although for a long time... largely restricted to two areas of Europe - the Low Countries (modern Belgium and the Netherlands) and England“. Another way to think of this is to look at the timing of establishment of new merchant guilds: where England is concerned, the evidence from Gross (1890) on the earliest references to specific English guilds starts with 1087-1107 (Burford charter), and ends with 1611 (Alnwick).

The reasons for merchant guilds’ decline are also a matter of debate among historians - there were in all probability multiple reasons. Can our model shed any light on the decline of merchant guilds? Hickson and Thompson (1991, pp. 154) note that “In 1692 England introduced a general property tax known as the ‘land tax’. The tax assessed not only land rents but also urban property rents and capital stock interest... While the tax initially failed to account for increased property values, a series of 18th century acts updated property values for tax purposes”. In terms of our model, the introduction and updating of this tax can be thought of as equivalent to a reduction in ψ , which makes it consistent with merchant guild decline in the 18th century.

⁴⁰Gross (1890), p. 47.

⁴¹Gross (1890), p. 48.

⁴²Gross (1890), p. 49. For many more examples, see Dessf and Ogilvie (2004) and Ogilvie (2011).

Evidence on changes in the cost of enforcing merchant guilds' monopolies in England is harder to obtain directly. However, we do know that there was significant trading activity in the countryside, in informal as well as formal trading centres: Dyer (1992) discusses many examples of this 'hidden trade' for the 14th, 15th and 16th centuries. Opportunities for merchants excluded from guilds to profit from such trade must have been limited early on. They must have grown substantially between 1300 and 1600, because of the following changes reviewed by Britnell (2000, pp. 12-13): (i) a "severe reduction in the proportion of the population who might be classified as cotters or labourers"; (ii) a "rising standard of living in rural society", associated with an "increased demand for merchant wares"; (iii) an "increasing propensity of consumers to buy goods from abroad"; (iv) the "increasing importance of exported manufactures for English employment and national income". Moreover, export-led production increased not only in large towns, but also in small towns and rural areas. For example, if we look at English cloth⁴³ production, we find that "In the first significant phase of export growth between 1350 and 1400 the chief beneficiaries were older towns... In the second main phase from the 1470s the chief beneficiaries were the rural or small-town industries of western Wiltshire, Devon and elsewhere".⁴⁴

In sum, higher rural demand must have created profitable opportunities for merchants, including merchants who were not guild members, who could sell imported goods to rural inhabitants, buy from them goods to be sold abroad, and increasingly trade with them goods produced in different parts of the country. Indeed, by the sixteenth century, we observe a substantial development of 'mercantile' networks that made it advantageous for artisans to live in particular towns and industrial villages, especially if they were producing goods in demand over considerable distances. "Local trade between village weaver and village tanner had given way, in part, to trade over longer distances with merchant intermediaries... non-agricultural activity grew in rural areas, but it was characteristically more merchant-dependent than in the thirteenth century".⁴⁵

In other words, merchant guilds' costs of excluding non-members from trade (x) increased substantially by the sixteenth century - which is consistent with the view that merchant guild decline started already in this period. Subsequent improvements in taxation further tilted the balance against merchant guilds, accelerating their decline. In this sense, our model helps to reconcile the different views put forward by historians.

4 Guilds, rulers and transfers: *Guilds will make transfers to rulers in return for their privileges, and they will be exempted from tolls imposed by tax collectors.*

In our model, under the 'guild' regime, merchant guild members are exempted from taxation by a tax collector, and use (part of) their collusive profits to make direct transfers to rulers.

⁴³Cloth became one of England's most important exports.

⁴⁴Britnell (2000), p. 14.

⁴⁵Britnell (2000), pp. 20-21.

The historical evidence shows that merchant guilds were indeed granted exemptions from a variety of tolls and other taxes, and made direct transfers to their rulers.⁴⁶ In England, for example, the same town charters that granted legal recognition and monopoly privileges to the local merchant guild generally granted exemptions from all tolls and other taxes, in exchange for a fixed sum or farm (*firma burgi*) to be paid annually by the town to the ruler (Gross, 1890). Membership of the local merchant guild carried corresponding duties and benefits: chief among the obligations was participation in the town’s assessments and payment of pecuniary charges, which ensured that the *firma burgi* was duly paid and the privileges granted in the charter maintained. On the benefit side, local guild members enjoyed the right to trade freely and were generally exempt from all tolls, while “unfranchised merchants, when allowed to practise their vocation, were hemmed in on every side by onerous restrictions. Of these the most irksome was probably the payment of toll on all wares that they were permitted to buy or sell”, Gross (1890).

Lyon and Verhulst (1967) argue that a similar pattern can be observed in France: one of the earliest examples is the town of St. Omer, which obtained freedom from all tolls and other taxes in 1128 in return for a fixed annual sum or farm. The local merchant guild in St. Omer enjoyed a variety of monopolistic privileges and contributed to the provision of local public goods.

5.2 Additional implications and historical evidence

Beyond the predictions just discussed, our analysis yields several other implications. We now discuss these, together with the historical evidence on them.

5 Exclusive membership and merchant inequality: *Guilds may impose restrictions on membership, and these may generate wealth inequality among merchants*

In our model, the negative implications of guilds for equality among merchants arise when the following three conditions are satisfied: (i) the optimal guild size falls short of the total number of potentially active merchants (i.e., $n^* < N$); (ii) the merchant guild generates a surplus relative to the revenues that would be raised by a tax collector (i.e., $W(n^*) > V^T$); (iii) the merchant guild has sufficient social capital, and hence bargaining power, to secure part of the surplus it generates (i.e., $\beta < 1$). In this case, guilded merchants will enjoy higher profits than excluded merchants.

Did local merchant guilds restrict membership? Historically, the answer is yes: membership was often contingent on having ‘citizenship’ or ‘burgess’ or ‘free’ status, from which many were excluded.⁴⁷ As towns grew, attracting large numbers of rural immigrants, this exclusion affected an increasing number of urban inhabitants. In England for instance, “big towns had populations

⁴⁶For examples see, among others, Ehbrecht (1985), pp. 425-6, on Germany; Hoffmann (1980), p.49, on Denmark; Racine (1985), pp. 135-6, on Italy; Smith (1940), pp. 48, 64-5, 85, and Woodward (2003), pp. 3-4, on Spain.

⁴⁷See Dilcher (1985), pp. 88-9, Epstein (2000), pp. 35-6, Leguay (2000), pp. 110-1, 121-2, Schütt (1980), p. 131, and Spruyt (1994), pp. 144.

most of whose members were not ‘free’ — e.g., two thirds in late-thirteenth-century in London, a half in Oxford and more than three quarters in Exeter” (Hilton, 1992, pp. 92).

A key requirement for membership of local merchant guilds was the payment of entry fees and a variety of dues⁴⁸, which is consistent with our model (members collectively needed to fund transfers to the ruler). This implied the exclusion of those who could not afford to pay the, often substantial, entry fees, or who were unable to provide the required guarantees: “To become a gildsman...it was necessary to pay certain initiation-fees...The new comer was also required to produce sureties, who were responsible for the fulfilment of his obligations to the Gild - answering for his good conduct and for the payment of his dues” (Gross, 1890, pp. 28). The historical evidence makes it clear that many of the towns’ inhabitants could not meet these requirements.⁴⁹ Moreover, admission to local merchant guilds was sometimes controlled by requiring that the potential new member be approved by a majority of existing members, and this requirement appears to have been used to restrict membership.⁵⁰

In sum, local merchant guilds excluded an increasing proportion of the urban population, notably the least wealthy.

6 Guilds’ social capital and town government: *Guilds with lower coordination costs (f) are more likely to engage in other collective activities that benefit guild members*

Our analysis highlights the importance of merchant guilds’ social capital in reducing members’ costs of coordination and organization. An important implication of this is that guilds with substantial social capital were likely to engage in additional collective activities - beyond those required to enforce successfully, and profit from, their exclusive rights over trade - which were in their members’ collective interest. Perhaps the most important example of this is the role played by merchant guilds in the emergence of town government throughout medieval Europe.

Fryde (1985, pp. 216-7), reviewing the contributions to English historiography by Tait (1936)⁵¹ and Martin (1963)⁵², notes how “in some towns the gild provided the first administration independent of the town lord, set up by the townsfolk themselves, regardless of whether the lord was the king, a nobleman or a great abbot... a large proportion of the so-called borough records which survive from the thirteenth century are, in fact, gild records”. Moreover, guilds often took on tasks normally undertaken by local government: “in Leicester and Bristol for instance, the gild was responsible for road, bridge and wall building and the gild chest fulfilled the role of a town treasury”.

⁴⁸For examples see Ehbrecht (1985), p.445, on entry fees for the merchant guild of Goslar; Dilcher (1984), p.69, and Volckart and Mangels (1999), pp.437-8, on dues levied by the merchant guild of Tiel; Schütt (1980), pp.112-21, on the dues levied by the merchant guild of Flensburg; Störmer (1985), pp.366-7, on entry fees for the merchant guild of Laufen; Origo (1986), p.44, on entry fees for the merchant guild of Prato.

⁴⁹See Hilton (1992), p. 92, and Schultze (1985), pp. 379-81.

⁵⁰See Smith (1940), p. 38.

⁵¹The Medieval English Borough (Manchester 1936).

⁵²G.H.Martin, The English borough in the Thirteenth Century, Transactions of the Royal Historical Society, 5th ser. 13 (1963), p. 131.

In Germany, merchant guilds in towns such as Cologne played a key role in gaining autonomy from feudal lords, and directing the administration of the town (Dollinger, 1964, pp. 27-28).⁵³ A similar pattern can be found throughout Italy (Racine, 1985, pp. 142-44). In France and Flanders, guilds played an important role in the politics and administration of towns such as Arras, Bruges, Ghent, Lille, Saint-Omer.⁵⁴

6 Extensions

The analysis developed up to this point hinges on a few simplifying assumptions. In this section we show that its basic insights carry over when these are relaxed, and obtain some additional implications.

Downward sloping demand and production costs. Our results clearly do not hinge on assuming a unit demand or normalizing merchant costs to zero. To see this, consider a setting in which merchants face a downward-sloping demand curve for their product, say $D(p)$, and a unit cost $c > 0$. We abstract from uncertainty for simplicity — i.e., normalize $\alpha = 1$.

Letting

$$p^M \equiv \arg \max_p D(p) (p - c),$$

be the monopoly price, we can define the monopoly profit as

$$\Delta \equiv D(p^M) (p^M - c).$$

It is then easy to show that the tax collector solution will entail setting a unit tax such that the equilibrium price will be the monopoly price — i.e., $t^\tau = p^M - c$ for every τ — and the tax collector will extract all the merchants' profits. Similarly, all the results derived in the regime with a guild will go through, with the difference that now Δ represents the monopoly profits.

Allowing explicitly for merchant costs is interesting because it highlights another important role for guilds: securing goods at the lowest possible cost to their members, thereby maximizing monopoly profits. In particular, it is clear from the analysis that the same coordination and collusion ability that allows guild members to exercise monopoly power efficiently relative to consumers can help them to exercise *monopsony* power relative to suppliers. Indeed, the pre-emption rights imposed by guilds on alien merchants (discussed in section 5.4) can be interpreted as facilitating the exercise of such monopsony power.

Imperfect commitment. Our baseline analysis assumed that the ruler can make long-term commitments. Thus both regimes entailed a single *ex-ante* transfer to the ruler: the tax collector paid for his future tax revenues from obtaining the tax farm, while the merchant guild paid for

⁵³Many of these towns became members of the Hanseatic League, a powerful federation of towns that went on to dominate the Baltic trade and much of the North Sea trade (Spruyt, 1994, p. 123).

⁵⁴Coornaert (1948, p. 216).

its future profits from being given recognition and privileges (exclusive trading rights). If the ruler cannot make long-term commitments, the single *ex-ante* transfer will be replaced by a fee paid to the ruler at the beginning of every period. For the tax collector, this makes no difference: each period, before observing the realization of demand, he pays his fee to the ruler, which is the expected value of what he will raise this period. Then he observes the realization of demand: if it is high he sets the tax rate $t^r = \Delta$ and collects the resulting tax revenues; if it is zero there is no trade and hence no tax revenues.

Under the guild regime, the equivalent of this is that at the beginning of each period, before observing the realization of demand, guild members get together and collectively pay the ruler a fee, equal to a share β of the expected value of their net joint profits in that period. If anyone does not pay his share of this fee, the guild is abolished, and all merchants make zero profits from then on. The key difference between this setting and the one with a single *ex-ante* transfer to the ruler is that merchants' expected future returns from collusion now have to take into account the future fees to be paid to the ruler, which makes it harder to sustain collusion: formally, the effect is akin to the effect of the coordination and organization cost f .⁵⁵

Thus imperfect commitment tends to make the guild regime less attractive, relative to the tax collector regime. One implication is that *kings and powerful lords should have been more likely to grant recognition and privileges to merchant guilds than smaller, less powerful lords*, since they had greater commitment power, other things held equal.

We investigated this implication using the list of English merchant guilds in Gross (1890, pp. 9-16). Of these, we found that 66% had been granted recognition and privileges by kings, and 16% by lords. For the remainder, it was difficult to establish whether the privileges were first granted by kings or lords, because some early documentation has been lost, and privileges were often confirmed at later dates by subsequent charters (typically by kings). Even if we assume that in all these cases the privileges were first granted by lords, it is clearly the case that the majority of merchant guilds were granted recognition and privileges by kings rather than lords. Moreover, the 16% figure includes merchant guilds granted by powerful lords such as Robert Fitz-Hamon, Archbishop Thurstan of York, and Richard, 1st Earl of Cornwall (second son of King John).

Constraints on the guild density. Lemma 1 and subsequent results hinge on assumption **A1** which guarantees that both a single-member guild and a guild that includes all merchants are viable. Now we argue that our qualitative insights would not change if these assumptions were relaxed.

Consider first $\Delta - x(N - 1) < 0$ and $\alpha\Delta - (N - 1)f \geq 0$: in this case a single monopolist is not able to prevent unauthorized trade by its $N - 1$ competitors, whereas operating costs are not so high as to prevent a full-size guild. Hence, a necessary condition for a guild to be viable

⁵⁵In practice, the historical evidence shows that transfers to rulers were often made once a year, while the appropriate unit for our trading "period" was the trading day. This suggests that rulers did have some commitment power.

is $\Delta - x(N - n) \geq 0$, which implies an endogenous minimal guild density $n_0 \equiv N - \frac{\Delta}{x}$. Recalling that

$$\Phi(n) \equiv \frac{\delta\alpha}{1-\delta} [\Delta - x(N - 1)] - (n - 1) \left[\Delta + \frac{\delta}{1-\delta} (f - \alpha x) \right]$$

it follows that a necessary condition to prevent undercutting is now $x \geq \bar{x}$. In this case $\Phi(n) \geq 0$ requires

$$n \geq n_1 \equiv 1 + \frac{x(N - 1) - \Delta}{x - \bar{x}}.$$

The ruler has thus the option of recognizing a guild if and only if

$$N \geq 1 + \frac{x(N - 1) - \Delta}{x - \bar{x}} \quad \Leftrightarrow \quad N \leq 1 + \frac{\Delta}{\bar{x}}.$$

When this condition is met, it can be easily verified that the optimal guild size is $n^* = N$, so that Propositions 2 and 3 still apply, but only for $x \geq \bar{x}$. Otherwise, the ruler prefers the tax collector.

Next, consider $\Delta - x(N - 1) \geq 0$ and $\alpha\Delta - (N - 1)f < 0$. This means that, in addition to the constraints stated in Lemma 1, there is an additional endogenous upper-bound to the guild density which comes from the constraint

$$\alpha(\Delta - x(N - 1)) - (n - 1)(f - \alpha x) \geq 0, \quad (3)$$

which can bind only when $x \leq \underline{x}$. However, in this region of parameters $n^* = 1$. Hence, the results of the baseline model go through even in this case.

Finally, it is straightforward to show that when

$$\Delta \leq (N - 1) \min \left\{ x, \frac{f}{\alpha} \right\},$$

the guild solution is not viable at all. In this case the only option left to the ruler is to hire a tax collector. Even if this result did not emerge in the baseline analysis, it is still in line with the comparative statics of Proposition 3, showing that the emergence of a merchant guild is positively correlated with Δ . It also highlights once more the importance of social capital for the guild solution.

Non-deterministic exclusion. In this section we consider how results are affected by relaxing the assumption that non-payment of exclusion costs by a single member is enough to give rise to undercutting with certainty (and hence zero guild profits). In particular, we assume instead that each member's exclusion effort increases the exclusion probability by $1/n$, so that if all members contribute there is exclusion, but if one member shirks exclusion succeeds with probability $(n - 1)/n$. As before, just for simplicity we assume that there is perfect monitoring — i.e., regardless of whether exclusion fails or not, if a merchant does not contribute to the exclusion effort in one period, the other members spot the deviation by the end of that period and either

exclude him from future trade or dissolve the guild, so that his profit in the punishment phase is zero.⁵⁶

An equilibrium in which active merchants quote the monopoly price and every member exerts exclusion effort can exist if and only if price deviations are not profitable — i.e., if

$$\frac{\Delta - x(N - n)}{n} + \frac{\delta}{1 - \delta} \left[\frac{\alpha(\Delta - x(N - n)) - (n - 1)f}{n} \right] \geq \max \left\{ \Delta - \frac{x(N - n)}{n}, \frac{n - 1}{n} \Delta \right\},$$

where the right-hand side represents the highest payoff a merchant can secure by undercutting the monopoly price. In fact, while undercutting p^M a deviating merchant can either decide to exert exclusion effort, in which case he obtains a profit of $\Delta - x(N - n)/n$, or he can refrain from contributing to exclusion, thereby taking the risk of letting outsiders enter the market with probability $1/n$, in which case he makes zero profits.⁵⁷ Note that

$$\Delta - \frac{x(N - n)}{n} \geq \frac{n - 1}{n} \Delta \quad \Leftrightarrow \quad \Delta \geq x(N - n),$$

which must be true in order for the guild to be profitable — i.e.,

$$\alpha(\Delta - x(N - n)) - (n - 1)f \geq 0 \quad \Rightarrow \quad \Delta \geq x(N - n).$$

Hence, when the guild is profitable, the best strategy for a deviating merchant is to undercut the monopoly profit and exert the exclusion effort — i.e.,

$$\max \left\{ \Delta - \frac{x(N - n)}{n}, \frac{n - 1}{n} \Delta \right\} = \Delta - \frac{x(N - n)}{n}.$$

This implies that the baseline analysis is still valid in an environment with a different monitoring technology, in which limited free-riding on the exclusion effort is less harmful than we assumed in the baseline model.

Imperfect collusion. Our baseline analysis for the guild regime entails perfect collusion when demand is positive — i.e., guilded merchants charge the monopoly price $p^M = \Delta$ if and only if $v^\tau = \Delta$. It is interesting, as an extension of the basic analysis, to consider circumstances in which imperfect collusion may occur in equilibrium. In particular, if demand can take more than two values, it can be the case that for very high demand states the equilibrium will entail imperfect collusion — i.e., guilded merchants will charge a price below the monopoly price (albeit still above the competitive price, hence still a collusive price). The intuition for this is that for very high demand states, the spot gain from deviation may be too high to sustain the perfectly collusive outcome.

⁵⁶This assumption is made only to simplify the exposition, it can be shown that nothing changes when there is perfect monitoring regarding price deviations but shirking on the exclusion effort is not observed if exclusion is successful. The proof is available upon request.

⁵⁷When exclusion fails the market equilibrium is the competitive one.

Formally, we can study this possibility by assuming that the consumer's willingness to pay, v^τ , is determined by the realization of a continuous random variable drawn from a uniform distribution with support $[0, 1]$, which is identically and independently distributed over time (see, e.g., Rotemberg and Saloner, 1986). For simplicity we abstract from explicit consideration of exclusion and coordination costs (i.e., we set $x = f = 0$), and just assume that one-member guilds are not feasible⁵⁸, so that the guild regime requires collusion.

Let n (where $N \geq n > 1$) be the subset of active merchants belonging to the guild. A collusive outcome is sustainable as long as it is in each merchant's best interest not to break the agreement. This requires

$$\frac{v}{n} + \frac{\delta E[v]}{(1-\delta)n} \geq v, \quad (4)$$

in any given state v . The left-hand side of this condition can be interpreted as the (discounted) gain from cooperation, while the right-hand side is the spot gain from deviation.

Rearranging equation (2), collusion can be sustained in state v if and only if

$$v \leq \frac{\delta E[v]}{(n-1)(1-\delta)}. \quad (5)$$

Thus for sufficiently large realizations of v it may not be possible to sustain full collusion — i.e., the potential gain from deviation becomes too large. In this case, the collusive agreement will require merchants to set the highest possible price level compatible with the ‘no cheating’ condition (5) so as to mitigate the temptation to undercut. More precisely, there exists a threshold $v^* \leq 1$ such that: for all $v \leq v^*$ full collusion is viable and each merchant obtains v/n , while for $v > v^*$ full collusion is not sustainable and the maximal profit that a guild member can obtain is v^*/n .⁵⁹ The threshold v^* is endogenously defined by (5) holding as an equality — i.e.,

$$v^* = \frac{\delta E[v]}{(n-1)(1-\delta)}, \quad (6)$$

where

$$E[v] = \int_0^{v^*} v dv + (1-v^*)v^*. \quad (7)$$

Hence, when demand is sufficiently high, the guild will obtain an aggregate profit (v^*) which is lower than the monopoly level. Substituting (7) into (6) we have

$$v^* = \frac{\delta}{(n-1)(1-\delta)} \left[\int_0^{v^*} v dv + (1-v^*)v^* \right] = \frac{2(1-n(1-\delta))}{\delta}.$$

⁵⁸Historically, we have found no records of one-member merchant guilds. The smallest guild size we are aware of is $n = 23$, for the fish merchants' guild in Worms (see Seider, 2005, p. 49).

⁵⁹The case where $v^* < 1$ corresponds to instances where in order to support collusion in states higher than v^* merchants must charge a price lower than the monopoly one. Formally, this implies that the guild total profit in each of these states is βv with $\beta = v^*/v \leq 1$.

Notice that the larger is the guild density — i.e., the larger is n — the lower is v^* , since each merchant is tempted to deviate more often when the gain from collusion has to be shared among many. Hence, a collusive outcome can obtain as long as the guild density does not exceed the endogenous upper-bound \bar{n} above which $v^* = 0$ — i.e.,

$$v^* > 0 \quad \Leftrightarrow \quad n < \bar{n} \equiv \frac{1}{1 - \delta},$$

with \bar{n} now being the solution with respect to n of $v^* = 0$. As a result, when N is large enough some merchants will be excluded from trade.

This extension of the model is interesting for two reasons: first, because it shows that restrictions on guild membership can arise as a consequence of the need to sustain collusive outcomes when faced with high realizations of demand. Second, because it highlights a possible advantage of the guild regime from the point of view of consumers, relative to the tax collector regime: consumers would clearly be better off under the guild regime in high demand states ($v > v^*$), since they would pay a price below the monopoly price.

Risk averse merchants. In our environment merchants, as well as the tax collector, are risk neutral. What would happen if they were risk averse? In particular: how would risk-aversion alter the trade-off between the guild and the tax-collector regimes? The answer is simple: other things being equal, risk-aversion can only make collusion more difficult to sustain in the guild regime, and hence favor the tax-collector solution. This is because risk-averse merchants will value less than risk-neutral merchants the uncertain future stream of collusive profits, and thus attach a lower weight to the continuation value of being in a collusive equilibrium, relative to the spot gain from a unilateral deviation. Thus in the presence of risk-averse merchants, demand uncertainty makes it harder to sustain collusion.

On the other hand, recent work by Abramitzky (2008) on the insurance role of a different institution, the Israeli Kibbutz, suggests that merchant guilds might also have offered some insurance benefits to risk-averse merchants, not available under the tax collector regime. The historical evidence supports this conjecture. One example we have already discussed is the role of merchant guilds in the government of medieval towns: this clearly helped to reduce the risk of a local administration and regulations unfavorable to merchants. Another example, based on evidence from guild statutes, is provided by Gross (1890, pp. 34-5): “Attendance at the funeral of deceased members, prayers for the dead, assistance to brethren in sickness, poverty and distress... are some of the precepts inculcated by the statutes”.

7 Concluding remarks

This paper has developed a theory of the emergence, operation and decline of merchant guilds. We have examined the costs and benefits to medieval rulers of granting recognition and exclusive rights to trade to merchant guilds, together with tax exemptions, in return for direct transfers.

Our theory has highlighted the role of the guilds' social capital in sustaining collusion, which is crucial for their ability to deliver sufficient benefits to rulers.

It is useful at this point to review alternative theories of merchant guilds, and relate them to our model. Greif *et al.* (1994), as noted earlier, provide a theory of the development of *alien* merchant guilds: that is, guilds of foreign (alien) merchants in a particular polity, who were granted recognition by the ruler of that polity. Their focus, therefore, differs from ours: we propose a theory of the development of *local* merchant guilds — i.e., guilds of local merchants in a particular polity, who were granted recognition (and privileges) by the ruler of that polity. Historically, the vast majority of merchant guilds emerged as local merchant guilds: only a subset of these went on to establish foreign branches, or consulates, in other polities - i.e. alien merchant guilds. Local merchant guilds dominated local trade and had a substantial impact on the development of medieval towns: to our knowledge, we provide the first formal model of this important historical institution.

It is nevertheless interesting to compare the two theories. The crucial ingredient of the Greif *et al.* theory is imperfect commitment by the ruler. We saw in the previous section that this does not provide an explanation for the emergence of local merchant guilds. In their model, it provides an explanation for the emergence of alien merchant guilds, as follows. The ruler can expropriate alien merchants who come to trade in his polity, or fail to provide a commercially secure environment. This reduces trade below the efficient level. The ruler would therefore like to commit not to 'misbehave' (expropriation, commercial insecurity). He cannot do so credibly unless alien merchants can, in turn, credibly threaten to boycott trade in the polity if the ruler misbehaves. This requires alien merchants to belong to an organization able to enforce its members' compliance with any trade embargo imposed by the organization: a 'guild'.

Interestingly, this provides a clear link with our work: in our theory, the most successful merchant guilds are those with higher social capital (lower x and f), enabling them to coordinate successfully and jointly undertake actions in their members' collective interest. We would, therefore, expect such local merchant guilds to establish foreign branches when a sufficient number of their members engaged in international trade. These foreign branches would coordinate members' actions in foreign polities, and their relationship with the rulers of these polities (including possible trade embargoes), in the members' collective interest. The historical evidence shows this is what happened: indeed, members had to belong to the local guild of their polity of origin in order to be admitted to any of its foreign branches, and the local guild enforced punishments against members who 'misbehaved'. Moreover, as our model would predict, alien merchant guilds often secured tax exemptions in return for direct transfers to rulers of the polities where they traded. Thus our theory can easily accommodate the development of alien merchant guilds, and shed light on their operation.

A different possible explanation for the emergence of merchant guilds concerns the ruler's time preference⁶⁰: rulers sometimes needed to raise substantial revenues to fund current expen-

⁶⁰Ogilvie (2011, p. 162) suggests this, pointing out that rulers were likely to discount the future more than

ditures (e.g., wars), and may have attached a greater weight to the present than merchants. However, this does not provide a compelling case for reliance on merchant guilds rather than, for example, tax farming. Indeed, our analysis has examined the trade-offs involved in choosing between these two alternatives. Finally, historians such as Gross (1890) and Brentano (1870) have given us invaluable insights into the evolution and operation of merchant guilds. However, their accounts, sometimes highly critical of merchant guilds' collusive practices, do not explain why medieval rulers were happy to grant merchant guilds recognition and privileges, including the exclusive rights to trade on which these collusive practices were based.

This paper has proposed a unified theory, able to reconcile previous explanations and the large body of historical evidence on medieval merchant guilds. In doing so, it has also shed some light on the role of the guilds' social capital, and its importance for taxation, welfare, and the development of towns and their government in medieval Europe.

merchant guilds.

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8 Appendix

Proof of Lemma 1. The proof of this result follows directly from the sign of the derivative of $\Phi(n)$. As explained in the text, $\frac{\partial \Phi(n)}{\partial n} \geq 0$ when $x \geq \bar{x}$. Hence, by **A1** the self-enforceability constraint (2) always holds in this region of parameters regardless of n . Next, consider the case $x < \bar{x}$. In this region of parameters $\frac{\partial \Phi(n)}{\partial n} < 0$. Hence, $\Phi(n) \geq 0$ if and only if

$$(n-1) \left[\Delta + \frac{\delta}{1-\delta} (f - \alpha x) \right] \leq \frac{\delta \alpha}{1-\delta} [\Delta - x(N-1)],$$

which yields immediately \bar{n} . Applying the Implicit function Theorem to $\Phi(n) \equiv 0$ it is easy to verify that

$$\frac{\partial \bar{n}}{\partial \Delta} = \frac{\frac{\delta \alpha}{1-\delta} + 1 - \bar{n}}{\Delta + \frac{\delta}{1-\delta} (f - \alpha x)},$$

where $\frac{\delta \alpha}{1-\delta} + 1 > \bar{n}$, otherwise $\Phi(n) < 0$ for any n . Hence, $\frac{\partial \bar{n}}{\partial \Delta} > 0$ in the region of parameters under consideration. Similarly, using **A1**, it can be shown that

$$\begin{aligned} \frac{\partial \bar{n}}{\partial \delta} &= \frac{\frac{1}{\delta(1-\delta)} \Delta (\bar{n} - 1)}{\Delta + \frac{\delta}{1-\delta} (f - \alpha x)} > 0, & \frac{\partial \bar{n}}{\partial x} &= \frac{\Delta - \bar{x}(N-1)}{(\bar{x} - x)^2} > 0, \\ \frac{\partial \bar{n}}{\partial N} &= -\frac{\frac{\alpha \delta x}{1-\delta}}{\Delta + \frac{\delta}{1-\delta} (f - \alpha x)} < 0, & \frac{\partial \bar{n}}{\partial f} &= -\frac{(\bar{n} - 1) \frac{\delta}{1-\delta}}{\Delta + \frac{\delta}{1-\delta} (f - \alpha x)} < 0, \end{aligned}$$

and that

$$\frac{\partial \bar{n}}{\partial \alpha} = \frac{\frac{\delta}{1-\delta} [\Delta - x(N-1)] + (\bar{n} - 1) \frac{\delta x}{1-\delta}}{\Delta + \frac{\delta}{1-\delta} (f - \alpha x)} > 0,$$

which completes the proof. ■

Proof of Proposition 2. Suppose first that $x \leq \underline{x}$. In this region of parameters the guild's objective function is decreasing in n and $\frac{\partial \Phi(n)}{\partial n} < 0$. Hence, the optimal density is $n^* = 1$, which is a viable solution under **A1**. Replacing $n^* = 1$ into the guilds' objective function one immediately obtains $W(n^* = 1)$.

Next suppose that $x \in (\underline{x}, \bar{x}]$. In this region of parameters the guild's objective function is increasing in n while $\frac{\partial \Phi(n)}{\partial n} \leq 0$. Hence, the optimal density is $n^* = \min\{\bar{n}, N\}$. Replacing $n^* = \min\{\bar{n}, N\}$ into the guilds' objective function one immediately obtains $W(n^* = \min\{\bar{n}, N\})$.

Finally, consider the range $x > \bar{x}$. In this case the guild's objective function is increasing and $\frac{\partial \Phi(n)}{\partial n} > 0$. Hence, the optimal density is $n^* = N$. Replacing $n^* = N$ into the guilds' objective function one immediately obtains $W(n^* = N)$. ■

Proof of Proposition 3. Suppose first that $x \leq \underline{x}$, so that $n^* = 1$. Comparing $W(n^* = 1)$ and V^T we have

$$W(n^* = 1) > V^T \quad \Leftrightarrow \quad \psi \geq \psi_0 \equiv \frac{x(N-1)}{\Delta},$$

which by **A1** is in the unit interval $(0, 1)$. Notice also that ψ_0 is increasing in x and N , and decreasing in Δ .

Next suppose that $x \in (\underline{x}, \bar{x}]$, so that $n^* = \min\{N, \bar{n}\}$. Consider the most interesting case in

which $\bar{n} < N$. Comparing $W(n^* = \bar{n})$ and V^T we have

$$\begin{aligned} W(n^* = \bar{n}) - V^T &= \frac{\alpha(\Delta - x(N-1)) - (\bar{n}-1)(f - \alpha x)}{1 - \delta} - \frac{\alpha\Delta(1 - \psi)}{1 - \delta} = \\ &= \frac{1}{1 - \delta} [\alpha\Delta\psi - \alpha x(N-1) - (\bar{n}-1)(f - \alpha x)]. \end{aligned}$$

Note that, as long as $\psi = 0$ then $W(n^* = \bar{n}) < V^T$, while $W(n^* = \bar{n}) > V^T$ when $\psi = 1$. Hence,

$$W(n^* = \bar{n}) > V^T \Leftrightarrow \psi \geq \psi_1 \equiv \frac{1}{\Delta} \left[x(N-1) - \frac{(\bar{n}-1)(\alpha x - f)}{\alpha} \right] \in (0, 1).$$

Using the definition of \bar{n} the threshold ψ_1 can be rewritten as

$$\psi_1 \equiv \frac{x(N-1)}{\Delta} - \frac{(\Delta - x(N-1))(\alpha x - f)}{\Delta\alpha(\bar{x} - x)}.$$

Recalling that

$$\bar{x} \equiv \frac{f}{\alpha} + \frac{(1 - \delta)\Delta}{\alpha\delta},$$

simple differentiation of ψ_1 implies that this threshold is increasing in N and f , while decreasing in δ and α . To study the impact of Δ and x it is more convenient to observe that by Lemma 1 \bar{n} is increasing in Δ and decreasing in x .

Differentiating with respect to Δ

$$\frac{\partial\psi_1}{\partial\Delta} = -\frac{1}{\Delta^2} \underbrace{\left[x(N-1) - \frac{(\bar{n}-1)(\alpha x - f)}{\alpha} \right]}_{>0} - \underbrace{\frac{\partial\bar{n}}{\partial\Delta} \frac{(\alpha x - f)}{\Delta\alpha}}_{>0},$$

implying that $\frac{\partial\psi_1}{\partial\Delta} < 0$.

Differentiating with respect to x we have

$$\frac{\partial\psi_1}{\partial x} = \underbrace{\frac{N - \bar{n}}{\Delta}}_{>0} - \underbrace{\frac{\alpha x - f}{\Delta\alpha} \frac{\partial\bar{n}}{\partial x}}_{<0},$$

implying that $\frac{\partial\psi_1}{\partial x} < 0$.

Finally, consider the region of parameters in which $n^* = N$. Comparing $W(n^* = N)$ and V^T we have

$$\begin{aligned} W(n^* = N) &\geq V^T \Leftrightarrow \alpha\Delta - f(N-1) \geq \\ \psi &\geq \psi_2 \equiv \frac{f(N-1)}{\Delta\alpha}, \end{aligned}$$

with $\psi_2 \in (0, 1)$ by **A1** and ψ_2 being increasing in N and f , and decreasing in α and Δ . ■